One-Hundred-Twenty-Eight Years of Research and Policy on Toxic Cyanobacteria: Where do we go from here?

Ohio Harmful Algal Bloom Workshop February 7, 2007 University of Toledo's Lake Erie Center, Oregon, OH



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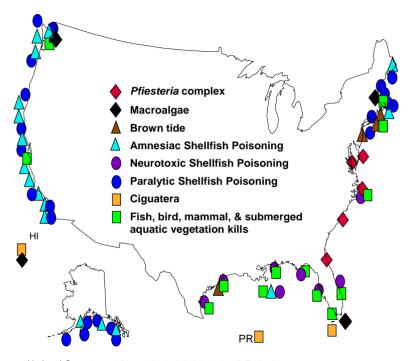
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Red Tide History

- 1928. Journal of Preventive Medicine. 2, 365-394. K.F. Meyer, H. Sommer and P. Schoenholz.
- (mussel poisoning cases San Francisco area, July 1927)
- →1950's-"Paralytic Shellfish Poisons"-Edward Schantz et al.-US Army Chemical Corps-Ft Detrick, MD.
- (isolation and biochemistry of PSPs-later called Saxitoxins)

Major Harmful Algal Bloom-related Events in the Coastal U.S.



Source: National Oceanic and Atmospheric Administration & D. Anderson

The Discipline of Harmful Algae Blooms

- 1974-First Int. Conf. Toxic Dinoflagellate Blooms (response to 1972 New England Red Tides)
- HAB XI--2004-Capetown, South Africa
- HAB XII-2006-Copenhagen, Denmark (proceedings to be published by ISSHA)
- 1978, 1985, 1987 (first to broaden scope of HAB types including CyanoHABs), 1991, 1993, 1995, 1997, 2000, 2002

Types of Harmful Algal Blooms

- Produce dense blooms leading to organism stress.
 - Dinoflagellates
 - Cyanobacteria (prokaryotic microbes)
 - Brown tide-Aureococcus ananagefferens
- Produce potent toxins—illness and death via food chain or biomass accumulation.
 - Paralytic shellfish poisoning (PSP)
 - Diarrheal shellfish poisoning (DSP)
 - Neurotoxic shellfish poisoning (NSP)
 - Ciguatera fishfood poisoning (CFP)
 - Estuary-associated syndrome (EAS)

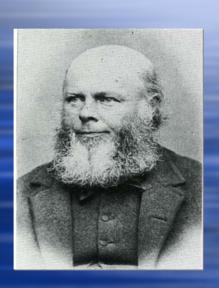
Dinoflagellate

Amnesic shellfish poisoning (ASP)

Diatom

- Cyanobacteria toxin poisoning (CTP)
- Haptophyte Golden Alga-Prymnesium parvum and Chrysochromulina brevifilum

Toxic Cyanobacteria-1878-"Poisonous Australian Lake"

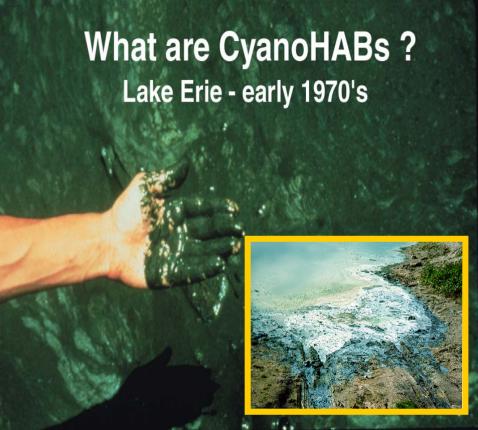


- Nature-May 2, 1878 (sheep poisonings)
- George Francis
- Similar early documented mass algae poisonings in the U.S. 1883, 1887, 1925

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

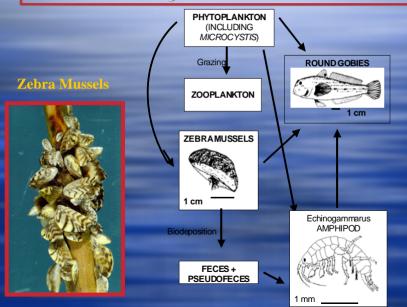
Paul Gorham-Vilna, Alberta Canada

Sept. 1971





Zebra Mussels and CyanoHABs



Courtesy: Dave Culver

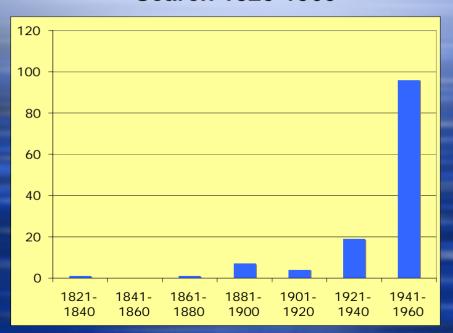
The Discipline of CyanoHABs

- 1980-First Int. Conf. On Toxic Cyanobacteria-proceedings entitled: "The Water Environment Algal Toxins and Health"-Plenum Press-1981(ed by WW Carmichael)
- 1993-Bath, UK; 1995-Bornholm, DK
- 1998-4th ICTC-Beaufort, NC, USA
- 2001-5th ICTC-Noosa, Queensland, AUS
- 2004-6th ICTC-Bergen, Norway
- 2007-7th ICTC-RDJ, Brazilhttp://www.biof.ufrj.br/cyano/

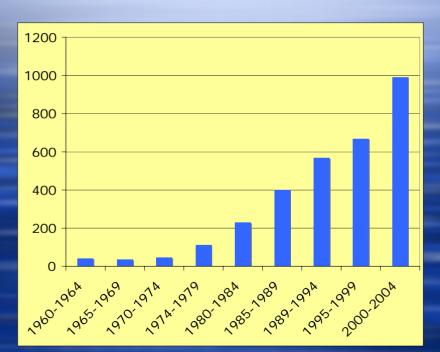
CyanoHAB Ref List

- lists all published studies of toxic cyanobacteria, and contains over 4000 references cited from over 700 journals written by almost 5000 authors and editors.
- The database is comprised of toxic cyanobacteria references in an electronic format (ProCite®) that can be searched, sorted and listed by author, year, title, reference source or subject.

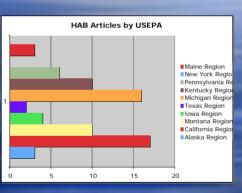
Number of Articles Cited in CyanoHAB Search 1820-1960



Number of Articles Cited in CyanoHAB Search 1960-2004



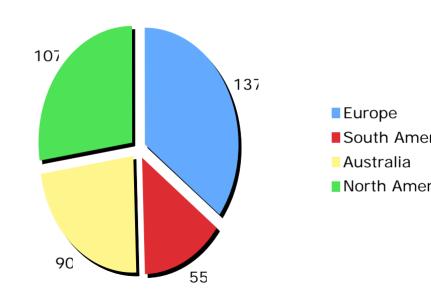
Incidence of CyanoHABs Per USEPA Region



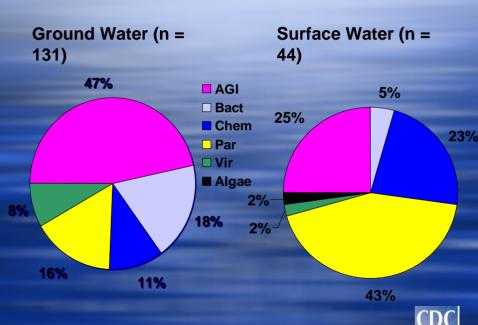
USEPA Regions

- Maine, New Hampshire, Vermont,
 Massachusetts, Connecticut,
 Rhode Island
- 2. New York, New Jersey
- 3. Pennsylvania, West Virginia, Virginia, Maryland, Delaware
- 4. Kentucky, Tennessee, North Carolina, South Carolina, Alabama, Mississippi, Florida, Georgia
- 5. Michigan, Ohio, Indiana, Illinois, Wisconsin, Minnesota
- 6.Texas, Louisiana, Arkansas, Oklahoma, New Mexico
- 7. Iowa, Missouri, Kansas, Nebraska
- 8. Montana, Colorado, Wyoming, Utah, North Dakota, South Dakota
- 9. California, Nevada, Arizona, Hawaii
- 10. Alaska, Washington, Oregon, Idaho

Reported CyanoHAB Incidents by C



Etiologic agents associated with drinking water outbreaks, by water type – United States, 1989-2000 (n = 175)



Occurrence and Health Significance Ranking of Cyanotoxins



Microcystins (most common of cyanotoxins; widespread poisonings)

Anatoxins (common; with animal poisonings)

Cylindrospermopsins (widespread in U.S.; poisonings from Australia)

Lyngbyatoxins (possible presence in continental U.S.; poisonings in S. Pacific)

Nodularins (unknown in NA; some animal deaths internationally)

Saxitoxins (sporadic; with some animal deaths)

BMAA (world wide; but health significance largely unknown) LPS (world wide; unknown)

U.S. HAB National Plan

 First Meeting on a U.S. National Plan for Marine Biotoxins and Harmful Algae -1993. Ref: Marine Biotoxins and Harmful Algae: A National Plan. Anderson, D.M. et al. WHOI-Jan. 1993. 44 pp.

 U.S. National Office for Marine Biotoxins and Harmful Algae. U.S. National Plan for Marine Biotoxins and Harmful Algae. 2003 National HABs Symposium, December 9-13, 2003, Woods Hole, Mass.

HAB Legislation U.S.

- Harmful Algal Bloom Eradication and Control Act of 1998-Subcommittee on Oceans and Fisheries-U.S. Senate
- Harmful Algae Bloom and Hypoxia Research Amendment Act of 2003-Subcommittee on Environment, Technology and Standards-U.S. House of Representatives Committee on Science (includes study of CyanoHABs in navigatable waters-i.e. Lake Erie)
- National Plan for Algal Toxins and Harmful Algal Blooms March 21-25, 2004 Workshop-Charleston, SC-NOAA

Current National HAB Plan

 HARRNESS=Harmful Algal Research and Response; a National Environmental Science Strategy 2005-2015.

The Report was produced by the Ecological Society of America with support from the National Centers for Coastal Ocean Science (NCCOS) part of the National Oceanic and Atmospheric Administration National Ocean Service. Proper citation of this document is as follows:

HARRNESS, 2005. Harmful Algal Research and Response: A National Environmental Science Strategy 2005-2015. Ramsdell, J.S., D.M. Anderson and P.M. Gilbert (Eds.), Ecological Society of America, Washington DC, 82 pp.

U.S. National Plan for CyanoHABs

- EPA- International Symposium on Cyanobacteria Harmful Algae Blooms-September 6-10, 2005
- Sheraton Imperial Hotel and Conference Center-RTP-NC
- Web site:
 http://www.epa.goy/eyano_habs_symposlum

CyanoHABs-1996 Safe Drinking Water Act Amendments-U.S.A.

- Authorizes regulation of contaminants in drinking water
- Establishes procedure for making regulatory decisions
- Requires at least 5 contaminants to be considered every 5 years
- Brazil is the only country to have CyanoHAB mandatory regulationsothers have guidelines

Contaminant Candidate List (CCL)

- Revised every 5 years
- First CCL published 1998
 - Included freshwater algae and toxins
- CCL2 promulgated 2004
 - Also includes freshwater algae and toxins
 - CCL3 due in Summer 2007

Priority Listing of Cyanotoxins for Action

- Microcystins-Analytical standards, rapid detection and setting of guideline values
- Cylindrospermopsins- Analytical standards, rapid detection and setting of guideline values
- Anatoxin-a- Analytical standards, rapid detection and setting of guideline values
- Saxitoxins, Nodularins, LPS-Secondary priority-pending further evaluation of occurrence in freshwaters
- This priority listing has now been used to develop:
 Toxicological Reviews of Cyanobacterial Toxins: Anatoxin-a,
 Cylindrospermopsin, and Microcystins LR, RR, YR and LA
- Office of Research & Development-National Center for Environmental Assessment-U.S. Environmental Protection Agency-Cincinnati, OH

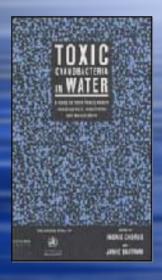


Australian Publications

- Australian Drinking Water Guidelines-1996-National Health and Medical Research Council (NHMRC)
- Evaluation of Analyt Meth Detect & Quant Cyanotoxins in Rel to Aust Drinking Water Guidelines-2001-NHMRC
- Guidelines for Managing Risks in Recreational Water-2004-NHMRC (Draft)
- Management Strategies for Toxic Blue-Green Algae: Literature Review. Aust. W.Q.C. House et al. 2004.
- Water Treatment Options for Dissolved Cyanotoxins. Aqua. 53:229-239. 2004

World Health Organization

http://www.who.int/water_sanitation_health/resources quality/toxicyanbact/en/



- Online Version of WHO Book "Toxic Cyanobacteria in Water: A Guide To Their Public Health Consequences, Monitoring and Management"
- Contains Links to Other WHO sites Related to Water Resources, Water Bourne Diseases, and Other Issues
- Second edition is currently being written

Web Listings

- 75,600 Hits from Yahoo Search Engine
- 14 International (Australia, Canada, New Zealand)
- ◆ 12 U.S. National
- 41 U.S. State (Alaska, California, Florida, Hawaii, Indiana, Maine, Maryland, Massachusetts, New Jersey, New York, North Carolina, Ohio, Rhode Island, South Carolina, Texas, Vermont, Virginia, & Washington)

Cyanonet

http://cyanonet.org/

- Part of UNESCO's International Hydrology Program (IHP)
- Goals To Assess the global data, materials, and needs pertaining to the occurrence of CyanoHABs, cyanotoxins, incidence of adverse health effects, epidemiological investigations, adverse effects on water supplies, management of blooms, and public outreach through education

Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water --- United States, 2003--2004

Chemicals/Toxins

- During 2004, two toxin-associated outbreaks occurred in untreated water venues in Nebraska. These outbreaks were attributed to elevated levels of microcystin toxin (17) from blue-green algae (i.e., cyanobacteria) in lakes, causing 22 cases of illness. The predominant illnesses in both outbreaks involved dermatitis and gastroenteritis. Patients who sought medical care had a combination of rashes, diarrhea, cramps, nausea, vomiting, and fevers.
- From: CDC Surveillance Summaries 12/22/06; 55(SS12):1-24.

Carcinogenicity of nitrate, nitrite, and cyanobacterial peptide toxins

Yann Grosse, Robert Baan, Kurt Straif, Béatrice Secretan, Fatiha El Ghissassi, Vincent Cogliano, on behalf of the WHO

International Agency for Research on Cancer (IARC) Monograph Working Group

- After review of the evidence, the Working Group concluded that microcystin-LR is "possibly carcinogenic to humans" (group 2B). For nodularins, fewer studies were available; accordingly, the Working Group regarded nodularins as "notclassifiable as to their carcinogenicity" (group 3)
- http//Oncology.thelancet.com Vol. 7 Aug. 2006 pp.628-629

Proposed plans for improving federal response to freshwater HAB events-International Cooperation*

International HA Boodination

International organizations with interests in HAB research and response. Blue represents organizations focused primarily on marine HABs and green indicates organizations with interests on freshwater HABs. For more information about these organizations, go to the following web sites

CYANONEThttp://www.cyanonet.org GEOHABhttp://ioc.unesco.org/hab/

IOC HAB Program

http://ioc.unesco.org/hab/intro.htm, SCOR http://www.jhu.edu/~scor/, IOChttp://ioc.unesco.org/iocweb/ind ex.php,

IHPhttp://typo38.unesco.org/index.p

ICSU http://www.ICSU.org, UNESCO http://portal.unesco.org Formla Condination United Nations International Educational, Scientific. Countil fr andOutura Occanización Sience (ICSJ) (UNESO) Simtif Intecoemental International Comitteen Ocenogaplic Hidday Ocenic Reports Commission ICC Pogam(HP (SCR) Golal Ecology and Œ Ocernogaply 6 Harnfu Alcal CANONE Harnfu Alcal Blooms Bom (ίAB Pogam

*Courtesy: Quay Dortch

Where do we go from here?

- Modified from-Chapter 5: Envisioning the Benefits of HARRNESS
- Improved Ability to Detect CyanoHAB Species and Analyze CyanoHAB Toxins
- Improved Capability for Monitoring and Forecasting CyanoHABs in a Cost Effective and Timely Manner
- **→ Improved Protection of Human Health**
- Improved Protection of Endangered Species and Improved Ecological Health
- Improved Prevention and Mitigation Strategies
- Improved Economic Cost Estimates of CyanoHAB Events
- Improved Economics for Water Treatment, Fisheries and Recreation
- **◆ An Educated and Informed Public**

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

Thank You

(From one Oregonian to another)